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UEPRINTING

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BLUEPRINTING

By

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Peoria, Illinois

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PREFACE

The subject of blueprinting has, up to the present time, received little or no attention in a popular form as a subject in itself. Brief treatment has been accorded it in a number of books on mechanical drawing, and in a few magazine articles. Such treatments, because of their publication as isolated articles or parts of larger works, have in most instances presented only a brief résumé, enough to give a general understanding of some particular phase of the subject.

The object of this book has been to present practical information about blueprinting and such practices as are in current use, in a form which will be of most service to blueprinters. It has been written in simple language with the view of its being used by students and others not familiar with the subject; and it is hoped that the subject will be so presented that more blueprinting especially in school shops will result.

With the exception of a few instances in this work the author makes no claim to originality. If the publication of this book will lead to a better understanding and practice in blueprinting, especially by students, it will have accomplished its object.

The author is indebted to Mr. Miles C. Fuller, of the Fuller Blueprint and Supply Company, Peoria, Illinois, for valuable suggestions and constructive criticism of this book. He is also indebted for information and illustrations to the following firms, manufacturers of, and dealers in, blueprint supplies, apparatus and machinery: Eugene Dietzgen Company, Chicago; Keuffel and Esser Company, New York; Frederick

Post Company, Chicago; The C. F. Pease Company, Chicago; American Ironing Machine Company, Chicago; and Williams, Brown and Earle, Inc., Philadelphia.

Peoria, Illinois JOHN F. FRIESE.
June 1, 1919

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CHAPTER I

PRINTING ROOM ARRANGEMENTS AND EQUIPMENT

1. Development of Blueprinting. — Mechanical drawing is now considered a universal language. The spoken languages of the various nations may differ greatly, but a mechanical drawing made in America or France or England can be read just as easily in Japan, Germany, or Russia or any other country where drawings of machines or structures are made to work from, as in the country where the drawing was made.

It was not a great many years ago that the drawings made were not only costly to produce, but costly to duplicate. Blueprinting was introduced into this country by the Swiss, and first shown at the Philadelphia Centennial Exposition, 1876. Before that time the original drawings were made and very carefully preserved. If a structure were being built the drawings would be kept in a little shanty near the scene of operations. The superintendent or foreman and the workmen would familiarize themselves with as much of the work as they could. They would then work until some question arose, and then they would have to go back to the shanty to look at the detail in question. Then again they would continue their work until some further problem presented itself. Needless to say such procedure was very expensive in time wasted.

The coming of the tracing and blueprint ushered in a new era, so to speak. Even large and complicated drawings could be reproduced at such a slight cost that the making of not one but several reproductions was a small matter. With several sets of blueprints so placed about the project under construction that the workers have ready access, much time is saved.

With the coming of the present industrial age came the necessity for making countless numbers of assembly and detail drawings for industrial shops. The value of the relatively cheap blueprint has become so recognized that at the present time it frequently happens that each worker on a given job will be given a blueprint or set of blueprints. After the job has been completed the blueprints may be disposed of. The tracings are usually rolled up into a small roll and placed in a fireproof vault for safe-keeping. If at some future time more prints are wanted, the tracings are readily obtainable, and any number of new blueprints can be quickly and cheaply made.

At first all blueprinting was dependent upon the weather conditions. This frequently caused great inconvenience and sometimes loss. A long spell of rainy or dark weather might seriously delay the work on buildings and engineering projects, and in industrial plants.

With the coming of electricity as we have it today came the electric lamps and especially the arc lamps. Blueprinting is now no longer dependent on the weather conditions, and little commercial blueprinting is done with sunlight as the printing means where large quantities are produced. Where electricity is high some firms still print with sunlight, using a rapid paper.

The time of printing, too, has been greatly reduced so that at present, with the aid of modern printing machinery, it is possible to print, wash and dry a blueprint, and have it ready for use in three minutes. Some of the large machines using 54-in. paper will print 13,000 square feet of blueprint paper in an eight-hour day.

2. Electric Printing Rooms. — When a new school building is being built it is sometimes possible to have a blueprinting room, or a combination of photographic dark room and blueprinting rooms, provided for in the manual arts or physics department. Of course, the primary consideration in the location of the room is the sunlight, if the printing is to be done by sunlight. If the printing is to be done by electricity the matter of location is not so important.

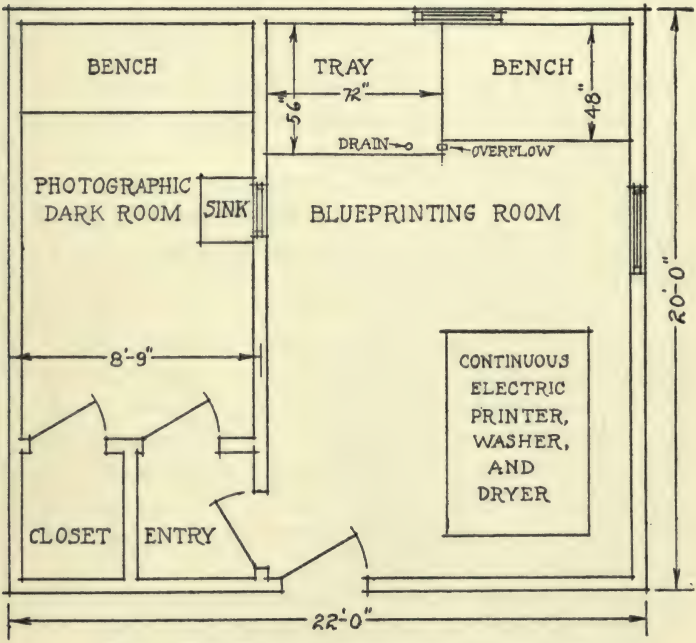

Fig. 1. Floor Plan and Arrangement of Blueprinting and Photographic Dark Rooms.

A possible floor plan and lay-out of a combination of two rooms for photographic and blueprinting work is shown in Fig. 1. It is designed to meet the needs of a large school or a small commercial shop. In a commercial shop, however, the photographic dark room of the illustration would be used for storing, cutting and handling the blueprint paper instead of for photographic work. The dimensions suggested could be increased or lessened to meet the individual needs as the case might be. A separate building constructed along the lines of the plan suggested would also prove satisfactory if there is no other available space. This applies to both a school and a commercial establishment.

The blueprint paper and other materials may be kept in the closet. The sink in the dark room is only intended for photographic purposes. The window in the partition just above the sink should be glazed with dark red glass. With the interior of the dark room painted black this window would let in just about the necessary amount of light for photographic work.

In the blueprinting room the walls and ceiling should be painted in some drab color. The window should be covered with a translucent shade; a white cotton one will serve the purpose. Or, the window panes may be painted with a very thin coat of red paint, and the curtain be omitted. There should be sufficient light in the room for the worker to readily operate the electric machine.

In a room of this size, in which a considerable volume of work will be done, it is best to build a permanent bath tray. One tray for water is all that is required to produce good work. By giving the blueprint a bath in a weak solution of bicromate of potash a greater contrast between the white and blue colors will result. A second tray will be serviceable if this is done, and also if special prints such as are treated in Chapter IV are made. However, one large tray will be found quite sufficient for ordinary blueprinting. These washing trays should be 44″ or 56″ wide and should be from 48″ to 72″ long. For further details see Sec. 17. The trays should be built from 6″ to 8″ deep. A good strong frame should support the tray. The frame should be built first and the lining made to fit the frame, if lining is used. Each tray should have a drain and overflow. Many are now using wood trays without lining, see Fig. 15.

Above the trays is a good place to put up whatever device is used to dry the blueprints. This allows whatever water drips off the wet sheets to fall back into the trays. Several methods of holding the blueprints while they are drying will be presented later.

The bench in the blueprinting room is for general purposes, but especially for trimming the prints to the proper sizes after they are dry.

The electric printing machine may be one of several types and sizes. Consult dealers' and manufacturers' catalogs to determine the kind and size best suited for your needs. The upright electric machine, Fig. 10, takes up the least amount of floor space. The electric continuous machine takes up more space, but is to be preferred where a considerable volume of work is required. Fig. 11 illustrates a continuous electric machine with an automatic washing and drying machine attached at the rear. Where funds are available this attachment to the continuous printing machine might be added. The washing and drying machine delivers the prints ready to be trimmed, and requires about as much floor space as the printing machine. The continuous electric printing machine alone, and the ironing machine, Fig. 12, might be used instead of the complete printing, washing and drying machine, Fig. 11.

3. Sunlight Printing Rooms. — In Fig. 2 is illustrated a room arrangement which is satisfactory for sunlight blueprinting. The developing room in this case does not have to be dark in the sense of the photographic dark room. It should have enough light to readily see to work by; about the same as in the blueprinting room in Fig. 1. The window should be treated in the same way as was suggested for the blueprinting room in Fig. 1.

In one end of the blueprinting room is the bench for trimming finished blueprints. The tracings and sensitized paper are placed in the printing frame in the developing room. The frame may be mounted on a wheel carriage, as illustrated in Fig. 5, and wheeled out of doors. Or, the frame may be placed on a carriage which rolls out of a window on a specially constructed track. Figs. 6 and 7 illustrate the latter carriages and the rails. Both of the frames revolve between the stand-

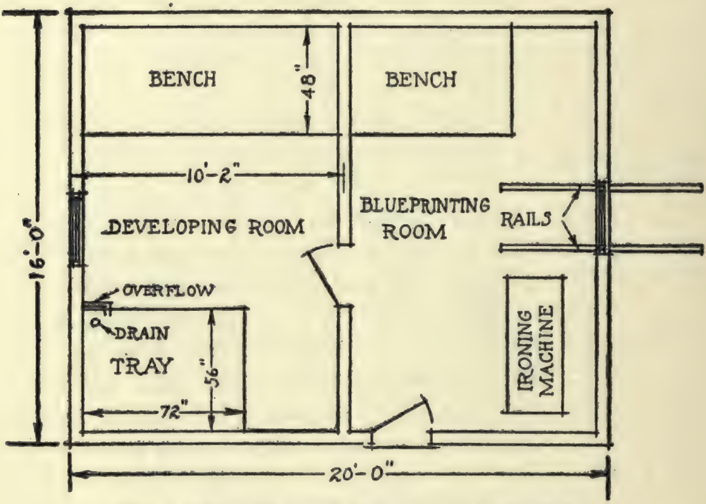

Fig. 2. Floor Plan and Arrangement for Sunlight Blueprinting Rooms

ards of the supporting carriages. In addition, the one in Fig. 7 is mounted on a turntable so that it can be turned in any direction to get the direct rays of the sun.

Where the printing is done by sunlight it is very convenient to have an ironing machine, Fig. 12; or blueprint wringer, Fig. 13, and an ironing machine. Small quantities of work would hardly warrant the purchase of an ironing machine.

The two sketches of floor plans and arrangements are merely suggestive. Individual needs, cost and available space are all items that enter into each individual case. It is possible to make very good small blueprints without a specially constructed printing room; with a simple hand frame, a table or bench, and a common sink, tub or large pan. The strainer in an ordinary kitchen sink can be removed and a large rubber stopper inserted. For small prints this serves very well as it usually has running water in connection with it.

4. Equipment. — Very excellent equipment can be purchased from dealers in drawing materials and blueprint supplies, or directly from manufacturers. Where a considerable outlay of money is undesirable it is possible to make nearly all the equipment necessary for sunlight printing with a good set of woodworking tools. Where a forge shop and machine shop are available it is possible to make just as good apparatus as can be purchased. In schools equipped with these shops and also an electrical department, it is possible to make a very satisfactory electric printing machine.

5. Printing Frames. — Straight grained, well-seasoned hardwood is the best material for printing frames. A wood is needed which will not readily warp or shrink when exposed to moisture or light rain. Oak is usually considered the best kind of wood to use. A cheap frame becomes very expensive if by warping it breaks a double thick glass or a polished plate glass.

Polished plate glass is to be preferred. It is much stronger and clearer. In a frame having over four square feet of printing surface the polished plate glass should always be used. The strength of such glass is required to withstand the pressure of the springs on the back of the frame. The breaking of a lighter glass not only means the replacing of the glass but may also mean the repairing or remaking of the tracing in the frame.

Good strong back-boards are necessary. The sections should be hinged together as illustrated in Figs. 3, 4 and 20. The back is held in place by cross-pieces or battens to which strong springs are attached. In the best frames all parts that receive heavy wear are made of metal, usually brass. The ends of the battens and the back-boards underneath the springs are frequently protected in this manner.

The strong springs press against the back-boards, and they in turn press the pad, sensitized paper and tracing against the glass. The backs are made in sections so that a part may be raised to examine the progress of the printing. The sectional back also assists one in placing the blueprint paper in the frame. When the paper comes off a roll it has a strong tendency to curl.

The soft pad or cushion is placed over the paper to insure a firm, even contact with the glass. Any unevenness in the contact of the paper and tracing will result in bad lines on the print. The pads are frequently made of a very thick piece of felt. Padded cotton is sometimes used, and a thick piece of Brussels carpet is very satisfactory. A white or light colored pad is most desirable as it hastens the printing somewhat. In small frames the pads are sometimes glued to the back-boards. A large photographic printing frame makes a very satisfactory blueprinting frame for small prints.

6. Construction of Small Sunlight Printing Frame. — Fig. 3 is a working drawing of a small printing frame. It allows

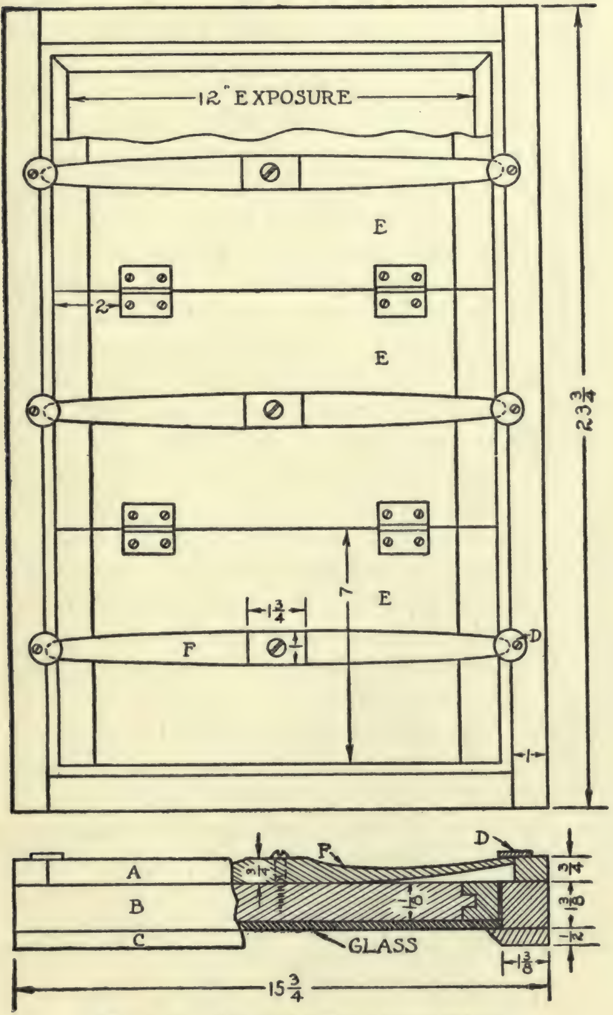

Fig. 3. Small Sunlight Blueprinting Frame

for a 12″ x 20″ exposure. The frame is of simple construction and can be made in any manual training shop by an eighth grade boy. If the corners of the main portion of the frame, marked B, are dovetailed, the construction will, of course, require more skill. That part marked B is constructed first. It may be made with butt, end-lap, miter, or dovetail joints. The under part, C, is next put on. The corners on these strips are mitered and the tops form the projection on which the glass rests. This projection is readily seen in the sectional view and at the top of the drawing where the exposure is indicated. The strips should be glued and screwed in place, the screw heads being countersunk. The four pieces marked A in the drawing are next attached. They are butt jointed at the corners and are fastened to B with screws. The back-boards, E, are constructed as indicated in the sectional view. The spring, F, in this frame is made of wood. It is modeled as indicated in the drawing and should be made just long enough to slip easily under the brass disks, D. These disks are attached to the frame by means of a screw. They are about an inch in diameter. The frame should be made of oak or some other strong wood. The back-boards might be made of softer wood, and the springs should be made of hickory or any springy wood. The dimensions on the drawing are all that are required for the construction of the frame.

7. Construction of Large Sunlight Printing Frame. — For a frame of larger dimensions a different type of construction is needed. In Fig. 4 is illustrated a frame having an exposure of 24″ x 36″. Larger frames can be built from the same design. A frame considerably larger would require another section in the back. The construction of this frame is evident from the drawing, and the necessary dimensions are given.

The battens, D, are hinged at one end and when closed down

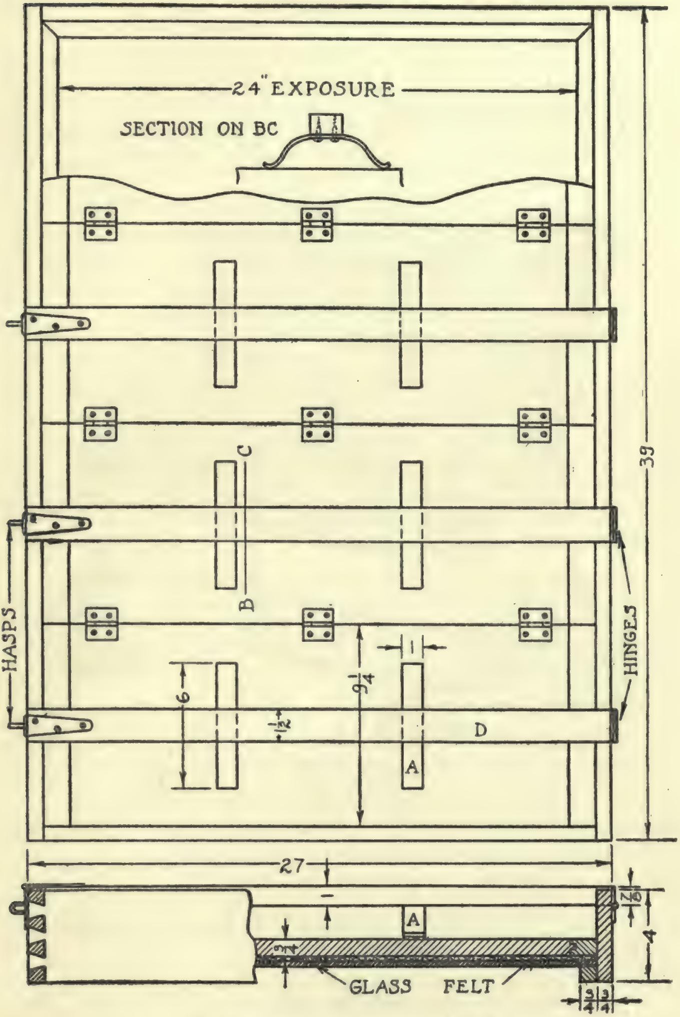

Fig. 4. Large Sunlight Blueprinting Frame

are held in place at the other side by means of hasps. These battens may be of equal thickness through their entire lengths, or they may be thicker in the middle as indicated in the drawing to withstand the pressure of the springs beneath them. The springs, A, are made of rather heavy spring brass. They are bent as indicated in the section at the top of the drawing. A good commercial frame of the same size as this one costs $19.00 or $20.00 complete with pad and polished plate glass.[1]

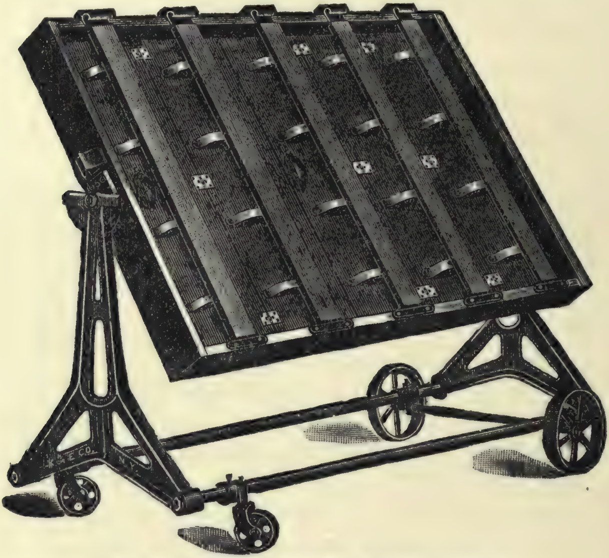

Fig. 5. Printing Frame on Wheel Carriage

8. Printing Frame on Wheel Carriage.— In Fig. 5 is illustrated a large printing frame on a carriage. A frame as large as the one illustrated is too heavy and clumsy to be carried to the place of exposure. The frame revolves between the uprights of the carriage and can be regulated to any angle during exposure. The carriages are built to receive the same firm's regular sizes of unmounted frames. Two of the wheels are on a common axle and two are swivel wheels. The carriages are light in construction and are readily pushed about. A commercial carriage and frame complete, with a printing surface 24"x30", costs between $35.00 and $40.00.

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[1] Prices on machines, apparatus and supplies in this book are pre-war. They are of value only as a basis for comparison. Those interested in current prices should write to dealers and manufacturers, some of whom are mentioned in the Introduction.

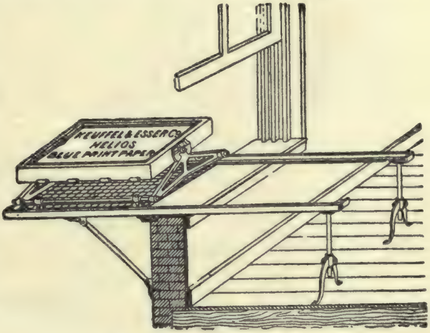

Fig. 6. Printing Frame on Tilting Carriage on Rails

9. Printing Frame on Tilting Carriage on Rails. — This type of carriage is very desirable where exposures have to be made outside of a window. In Fig. 6 is illustrated one type which revolves between the uprights of the carriage, and is regulated much like the one in Fig. 5. The track on which the carriage runs is constructed of angle iron. The hand frames of the same firm manufacturing the carriages will fit in the carriages. When ordering carriages of this style consult catalogs for the dimensions required for the construction of the track. A 30" x 42" frame completely equipped and mounted on a carriage like the one shown in Fig. 6 costs in the neighborhood of $60.00. Schools equipped with good metalworking shops can readily construct a carriage and track which will give satisfactory service.

10. Printing Frame on Tilting and Revolving Carriage on Rails. — A carriage which has considerable advantage over the one illustrated in Fig. 6 is shown in Fig. 7. The added advantage is in the construction of the carriage so that the top part holding the frame can be revolved vertically on the truck. This feature allows for the securing of a direct exposure. Such a carriage, mounting a 30″ x 42″ frame, costs from $75.00 to $80.00.

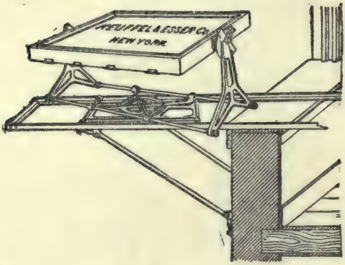

Fig. 7. Printing Frame on Tilting and Revolving Carriage on Rails

11. Revolving Window Carriage. — Fig. 8 is a sketch of a printing frame carriage which may meet special conditions better than some of the other types. The basic idea for this sketch was obtained from a photograph of a carriage made by George G. Greene, of the Lane Technical High School, Chicago.

A vertical pipe, A, revolves in sockets D and E. The lower socket is just one-half the depth of the upper one. The vertical pipe is about ½″ longer than the distance from the top of D to the bottom of E. The sockets must be large enough to give the pipe a little "play." The whole carriage can be lifted out of the sockets when not in use. The wood part, B, is attached to two iron arms made of ¼″ x 1″ iron. The iron arms are bent about, and attached to a triangular cast iron piece, G, which revolves about the standard on the collar, F. The frame, C, is held in place by cross-pieces on the arms and a hook at the top which slides up and down on the vertical pipe.

12. Vacuum Printing Frame. — A Vacuum frame is illustrated in Fig. 9. These frames come in large and small sizes. The distinctive feature of this frame is the action of the vacuum in keeping the tracing and sensitized paper in continuous and smooth contact with the glass. After they have been placed in the frame and covered with the pad the rubber back is laid over the whole and clamped down around the edges by means of bars. The rubber is so formed under the bars that when they are in place the inside becomes airtight. A hose connects the pump with the valve in the rubber back. When the pump is operated a vacuum is formed between the glass and rubber back and the back presses in against the whole surface of the glass. An electric motor driven pump and tank can be purchased which provides a continuous vacuum rather than an irregular one such as is caused by the strokes of a hand pump. The pumping must be continued during the whole time of the exposure. A vacuum frame, having a 30" x 42" printing surface, together with glass and hand pump, costs about $75.00.

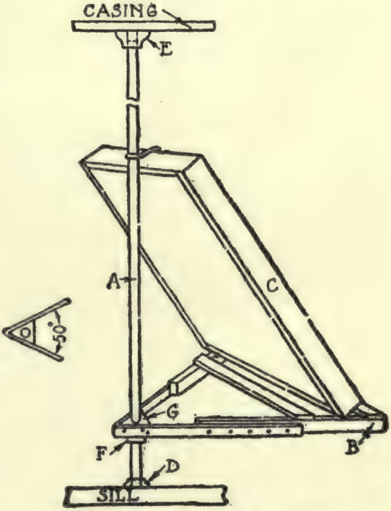

Fig. 8. Revolving Window Carriage

13. Upright Electric Printing Machine. — The electric printing machine shown in Fig 10 is one which is adapted to the needs of schools and small firms. A valuable feature is the small amount of floor space required for the machine. The one shown in the illustration has one semi-cylindrical printing surface 42″ x 48″. Such a machine costs about $200.00. Another machine built on the same principle has two semi-cylindrical printing surfaces, each surface running in sizes up to 42″ x 72″. A large machine of this latter style costs about $350.00, and has double the capacity of the same size machine with one semi-cylindrical surface. Such a machine is used where larger prints and greater volume of work are required.

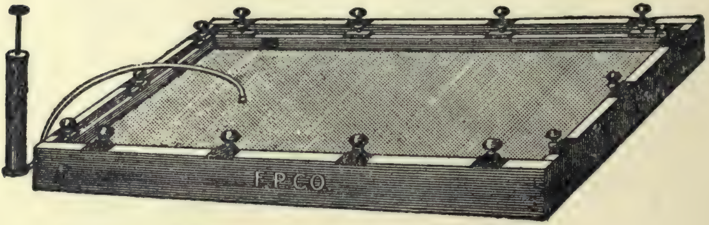

Fig. 9. Vacuum Blueprinting Frame

These machines require a floor space of 36″ x 42″. As only a single lamp is required, no matter what size the tracing, and as the current is shut off the moment the printing is accomplished this machine is a very economical one. No special value would be derived from a lengthy description of the machine and its operation. Directions for operating these machines can be secured from the firms handling them. For a brief description of their operation see Sec. 32.

14. Continuous Electric Printing Machine. — A continuous electric machine, with a washing and drying machine attached at the rear, is illustrated in Fig. 11. Where a large volume of work is required a machine of this type is economical, quick and easy to operate. A large part of the operation is automatic. The machine is simple enough for a boy to operate. Detailed directions for operation can be secured with the

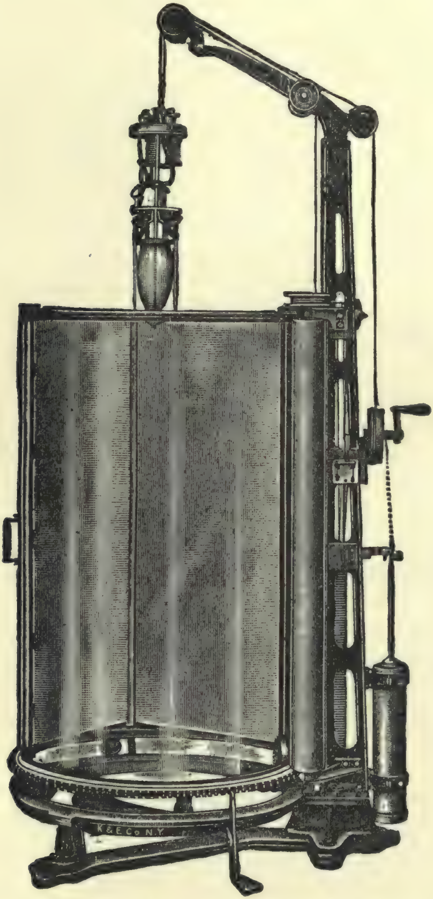

Fig. 10. Upright Electric Printing Machine

machine. These machines make continuous prints and can be adjusted in different ways to meet special conditions. A brief description of the operation of this type of machine will be found in Sec. 33. The continuous machines alone range in price, according to size and current, from $650.00 to $1200.00,

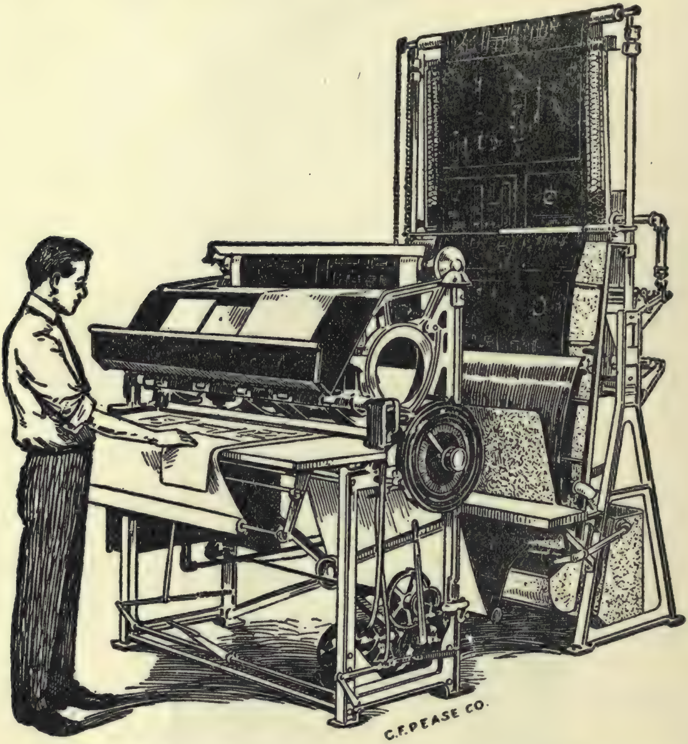

Fig. 11. Continuous Electric Printing Machine with Washing and Drying Machine Attached at Rear

and a washing and drying machine to be attached at the rear costs an added $500.00 to $700.00.

15. Ironing Machine. — Fig. 12 illustrates an ironing machine. When a print has been made in a sunlight printing frame, an upright electric machine or a continuous electric machine without the attached washing and drying machine, and it is desired to have the print completed rapidly, this machine will be found of real service. The wet print is rolled out smooth between the rolls and carried around the heated

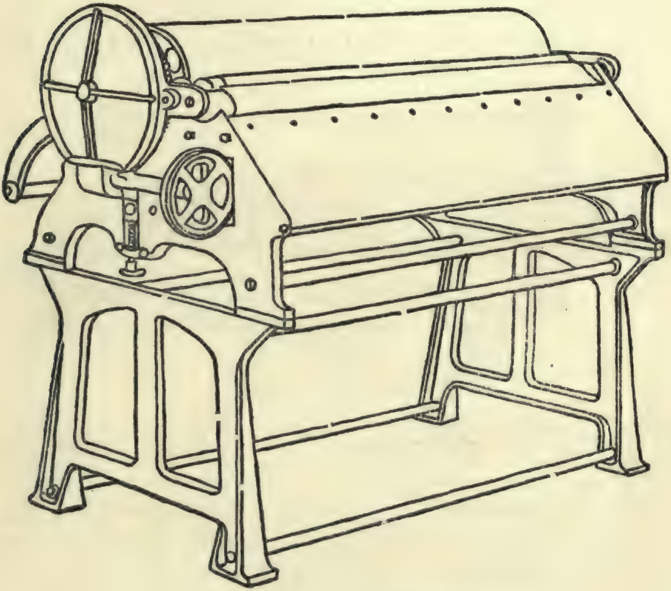

Fig. 12. Ironing Machine

cylinder on a continuous apron of heavy cloth. In these machines the cylinder is heated from the inside with gas, gasoline or electricity. When the print has gone around the cylinder and through the rolls it comes out smooth and dry ready for trimming. The machine is usually run by a small motor, but hand operated ironing machines can also be purchased.

These machines come in various widths up to a size that will take 54″ blueprint paper. Good machines can be purchased for $200.00 and upward. Prices depend on size, whether the cylinder is heated with gas or electricity, and whether or not a motor is desired to drive the machine.

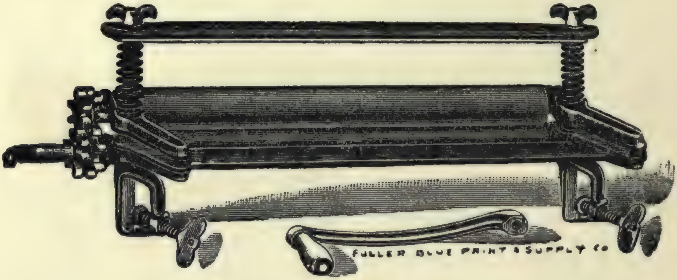
FULLER BLUE PRINT & SUPPLY CO

Fig. 13. Blueprint Wringer

16. Blueprint Wringer.— A blueprint wringer is illustrated in Fig. 13. These machines can be purchased in 24″, 30″, 36″, and 42″ widths. With their use much time can be saved when the drying is not done by a machine. The print is run through and all the water pressed out. This leaves the print moist but not soaking wet. It is also desirable to run a print through the wringer before putting it through the ironing machine described in Sec. 15. These wringers range in price from $50.00 to $70.00, depending on the size.

17. Trays. — A commercial tray made of zinc is illustrated in Fig. 14. It is built on a hardwood frame and has a drain in it. The top is turned over a strong wire rim. Trays of this style can be purchased in sizes ranging from 20″ x 24″ to 56″ x 72″, and cost from $5.00 to about $18.00. Plainer trays than these are also obtainable at less cost.

When a room is being equipped for blueprinting the tray or trays should be built in permanently. Frames are easily constructed and a tinsmith can make the lining if the tray is to be lined. Zinc should be used for the lining, as it will not rust. It is not essential to have an expensive tray to obtain good results, but the chances for failures are greater with poor equipment. Tanks, sinks, tubs and other vessels for holding water can be used when necessity requires.

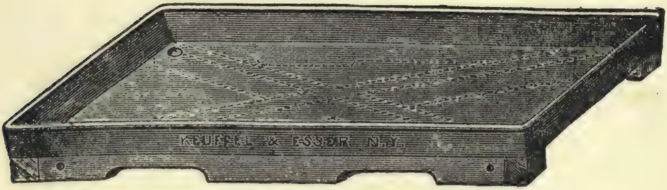
KEUFFEL & ESSER N.Y.

Fig. 14. Zinc Tray with Hardwood Frame

Wood trays are now being built and used quite extensively, especially where the tray is built in the room as a permanent fixture. Where large blueprints are made the tray should be 44″ or 56″ wide and from 48″ to 72″ long. It should be long enough to allow space for the hand to splash water over the print. With care, a print longer than the tray can be washed by folding it and washing one side at a time. Fig. 15 is a drawing showing the construction of a wood tray. The dimensions should be determined by the needs of the school or factory. The frame which supports it is not shown. The bottom should be made of matched material 1⅝″ thick. The sides are made of 1⅝″ x 8″ stock and the ends are of the same thickness, dressed down to make them flush with the sides. A bolt is placed in each end to hold the sides and ends together. The bottom may be securely spiked on, or the sides may be grooved and the bottom rabbetted to fit, as shown in the drawing. Red lead might be used in the joints. The inside of the tray should be painted with an asphaltum paint.

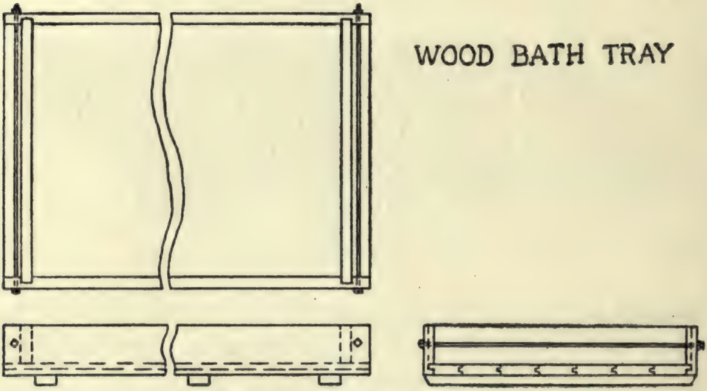

Fig. 15. Wood Bath Tray

18. **Hangers.**— Some device for holding blueprints while drying is required. The simplest method of drying is to hang the wet prints over a rope stretched across the room. Spring clips, Fig. 16, clamped to the prints and hung on a rope or wire are more satisfactory. They can be purchased from supply houses for about 25 cents per dozen. Patented automatic hangers which require little space and to which the blueprints

can be readily attached, can also be purchased in prices ranging from $1.50 to $5.25. Fig. 17 illustrates such a hanger. The number of holders on a bar ranges from 10 to 35. Fig. 18 is a drawing of a drying frame which can readily be constructed from a 2″ x 4″ piece and some old broom handles, or sticks having the top side rounded. It can be made any length. The arms are removable. A wet print is slipped over an arm and then it is returned to its socket. A good place for such a drying frame is above the tray. The water dripping from the prints will then drop into the tray.

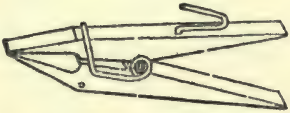

Fig. 16. Spring Clip

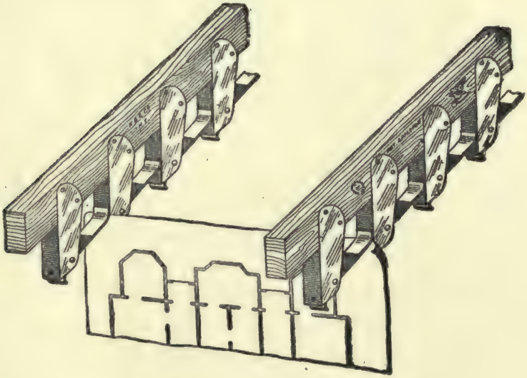

Fig. 17. Automatic Hanger

19. Tubes. — The best method of preserving prepared paper is to place it in a dust- moisture- and light-proof tube. These tubes are made of tin or pasteboard. They come in lengths from 31″ to 55″, and in sizes suitable for 10 and 50-

yard rolls of paper. Tin tubes cost from \$1.00 to \$1.70 according to size. Pasteboard tubes with close-fitting caps cost from 8 cents to 15 cents. A heavy pasteboard tube with a fixed metal cap on one end and a metal screw cap on the other costs from 30 cents to 70 cents according to size.

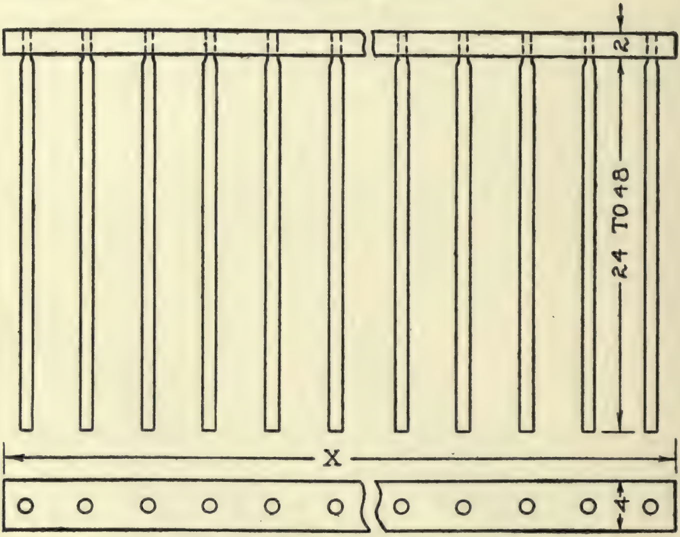

Fig. 18. Home-made Drying Frame

A tube of this latter type can easily be made from a plain cardboard mailing tube and a strong cardboard container having a tin bottom and tin screw cap. The sketch, Fig. 19, shows how they are put together to make a tube. The container is cut in half and the sections are placed on the ends of the mailing tube. The diameter of the mailing tube must be such that it will just slip inside of the halves of the container. If the tube is a trifle large it can be sandpapered down. The three parts should be glued together and the whole given a coat of varnish or shellac.

A good pair of trimming shears should be a part of every blueprinting equipment.

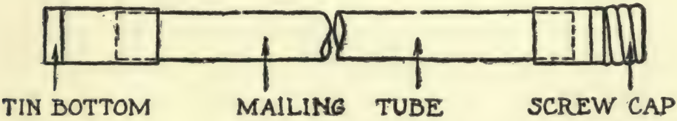

Fig. 19. Home-made Cardboard Tube

20. Cabinets.— It is frequently desirable to have a filing cabinet or a plain cabinet of drawers in the blueprinting room. Such a cabinet may be used either for the temporary or permanent filing of the blueprints as they are finished. Many very handy types of filing cabinets can be purchased. These are desirable, though a simple cabinet, either home-made or made in the school shop will often meet all requirements.

CHAPTER II

BLUEPRINT PAPERS

21. Blueprint Papers. — Only the simple blue process papers will receive attention in this chapter. In a later chapter the blue-line and black-line prints, Vandykes and other special prints will receive further treatment.

The relatively low prices of commercial papers usually make it inadvisable to spend the time sensitizing one's paper. However, it sometimes happens that a person finds himself without prepared paper. It is particularly with such emergencies in mind that the methods of sensitizing paper are given in this chapter.

Prepared blueprint paper is generally of a light greenish-yellow tint. During the summer months the paper may turn darker, usually a blue-gray color. The change in color does not mean that the paper is spoiled or that good prints cannot be made from it. The only method of determining whether or not a paper has been injured is to test it. Generally speaking manufactured papers should keep their strength three months. They frequently keep in a satisfactory condition for a much longer period than that. The keeping qualities of paper depend largely on the printing speed of the paper and the humidity of the atmosphere. Always keep rolls of paper on end whether in tubes or large boxes.

Like many other things, very cheap papers are not economical. Such papers give inferior results and deteriorate more rapidly than better papers. Time and money are frequently lost by the tearing of the wet prints. However, for a very simple print which will be required for only a short time, such papers may serve the purpose.

22. Weights of Blueprint Paper and Cloth. — Commercial papers are usually classified as to weight under four heads: extra thin, thin, medium thick and thick. Extra thin papers are made especially for mailing purposes. They are too thin for satisfactory service in a shop or on an engineering project. Thin papers are particularly desirable for large prints which would be bulky on heavy paper. Medium thick paper is the kind most generally used in school shops and commercial establishments. The thick paper is largely used for small prints that are subject to hard wear. Maps and some school shop drawings are made on this kind of paper.

Blueprint cloth comes in two thicknesses, extra thin and medium. The former is intended especially for large prints. The medium cloth is for smaller prints which are to be subjected to hard wear. A parchment paper is also made which will sometimes fit specific needs very satisfactorily.

Another method of making a very durable blueprint is to make the print on thin or medium thick paper and glue it onto a piece of cardboard or other heavy material. Paste, glue or shellac may be used as adhesives. After the paper has thoroughly dried the whole should be given a coat of white shellac. This method of mounting has been found especially satisfactory in school shops, particularly in machine-shops where the prints receive hard wear from the oily hands of many boys over a considerable period of time.

23. Printing Speed in Bright Sunlight. — Commercial stock blueprint papers are usually made in three speeds, called "Regular," "Rapid" and "Electric Rapid."

Regular paper requires from 4 to 8 minutes' exposure in bright sunlight. For school purposes especially, and for amateurs, this paper is quite satisfactory. It may be handled more easily than the fast paper, it keeps well and makes very satisfactory prints. However, many schools and commercial plants use the Rapid paper for sunlight printing in order to save time.

Rapid paper requires an exposure of about 2 minutes. This paper is used where the facilities for making the prints are quite complete, and where time and production count. It is sometimes used where the available light is not very good. Greater protection from light, when not in use and while being placed in the printing frame, is required for this paper than of the slower or Regular paper.

The Electric Rapid paper prints in about 25 seconds. It is made especially for electric printing machines.

An Extra Rapid paper which requires an exposure of from 30 to 40 seconds can be purchased from some supply houses. It can be used for electric printing and for sunlight printing under adverse weather conditions.

Some manufacturers are prepared to furnish papers at other speeds than those indicated here. Orders for special papers would necessarily have to be quite large, and in general the plan of using such papers is not advisable. The unusual conditions necessitating such papers should be explained when the order is made.

24. Sizes of Prepared Papers. — Blueprint papers come in rolls of 10, 50 and 100 yards. They can be secured in 24″, 30″, 36″, 42″, and 54″ widths. Some manufacturers are willing to cut the prepared paper into sheets of given dimensions, providing the order is large enough to warrant it. For small orders a slight advance in price is made for cutting the paper.

Where blueprints are all to be the same size it is often desirable to have the sheets cut, and packed in small, light-proof packages.

When ordering blueprint paper and cloth be sure to state the printing speed desired. If the paper is to be used in an electric machine that should also be stated. An order might be stated thus: Two 50-yard rolls, 30″ wide, medium thick, Regular, blueprint paper.

25. Prices of Blueprint Papers. — The prices of blueprint papers, blueprint cloth and unprepared paper, vary more or

Table I

Medium Thick, Blueprint Papers

Width Inches	*Price, Depending on Quality*	
	10-*yard Roll*	**50**-*yard Roll*
24	$0.70 to $0.95	$3.25 to $4.50
30	.70 “ 1.45	3.00 “ 5.75
36	.80 “ 1.65	3.50 “ 6.85
42	.90 “ 1.85	4.00 “ 8.00
54	1.50 “ 2.30	6.85 “ 10.75

Table II

Medium Blueprint Cloth

Width Inches	*Price, Depending on Quality* **10**-*yard Roll*
30	$2.90
36	$3.20
42	$4.00 to $4.40
54	$6.00

Table III

Medium Thick, Unprepared Blueprint Paper

Width Inches	*Price* **50**-*yard Roll*
30	$4.20
36	4.95
42	5.50

less according to market conditions of paper and chemicals, and the quality and brand desired. The prices listed are intended only to give the reader a basis for comparison. Thickness, quality and size of roll are taken into consideration in the price, but speed is not. The prices, Tables I, II, III, like those in the previous chapter are pre-war.

Generally speaking, the heavy papers cost more than the light ones. By comparing the cost of a 50-yard roll of unprepared blueprint paper, Table III, with the cost of a like roll of prepared paper one may quickly judge whether or not it is worth his time and the cost of materials to prepare the paper himself.

26. Making Sensitized Paper. — Some people still find it desirable to sensitize their own paper. Occasions may arise, too, when for some reason or other it is impossible to secure prepared paper. It is therefore a great convenience to the blueprinter to be able to prepare the paper himself. The following formulas, and the method of making prepared paper are given for any who may wish to make the blueprint paper. Students and others interested in blueprinting will also find the preparing of blueprint paper a very interesting and instructive experiment.

27. Sensitizing Solutions. — For an ordinary, slow printing paper use the following formula:

I. Dissolve 1 oz. of ammonium citrate of iron (red crystals) in 6 oz. of distilled or rain water.
II. Dissolve 1 oz. of potassium ferricyanide in 6 oz. of distilled or rain water.
When ready to use mix equal quantities of I and II. Mix only what you will need for the job in hand.

When a rapid paper is desired the following formula may be used:

I. Dissolve 1⅓ oz. of ammonium citrate of iron (green crystals) in 6 oz. of distilled or rain water.
II. Dissolve ½ oz. of potassium ferricyanide in 6 oz. of distilled or rain water.
Mix equal quantities of I and II to the amount desired.

For an extra rapid or electric solution use the following formula:

I. Tartaric acid, 1½ oz.; distilled water, 6½ oz.; ferric chloride solution (sp. gr. 1.45), 1 oz. Slowly add 3 oz. of liq. ammonia to neutralize.
II. Dissolve 1 oz. of potassium ferricyanide in 4½ oz. of distilled or rain water.
Mix equal volumes of I and II when desired.

Sunlight has no effect on these solutions when kept separate. It is considered best, however, to keep them in dark colored glass bottles with good stoppers. The citrate of iron solution does not keep long and it is best to mix only enough for the single job in hand. The chemicals used are not expensive. Frequently they can be purchased at a pharmacy.

28. The Process of Sensitizing Paper. — Only the unprepared commercial papers or an unsized or well washed paper should be used. A bond or parchment paper is satisfactory. If a blueprinting solution is applied to a sized paper, it immediately becomes discolored. Likewise any paper will discolor which has not had all the sulphur which was used in its manufacture washed off.

Cut the paper into sheets of the required size. A very easy way to keep the sheets flat while applying the sensitizing solution is to form them into a pad. This pad can be built up by placing a drop of mucilage, paste or glue in the extreme corners of each sheet, and then simply piling the sheets one on another.

Mix what you judge will be about the right amount of sensitizing solution. A glass or pottery vessel is the best to mix the solution in. Apply with a camel's hair brush or sponge, brushing the solution both with and across the grain of the paper to insure an even coating. Pull off the coated sheet and hang it up to dry. The drying may take from five minutes to a couple hours, depending upon the heat and humidity of the room. Do not try to dry the paper over-rapidly by applying great heat, for extreme heat will cause the paper to discolor just as sunlight does.

Another method of coating is to float the sheet of paper a few seconds in a sensitizing bath. A shallow pan is the best kind of a vessel for this purpose. Needless to say, all of the work of sensitizing and drying must be done in subdued light, orange or red light being the best. As soon as the paper is dry it should be rolled up and put in a light-proof container, or well wrapped in paper and placed in a drawer or other dark place until needed.

Other supplies such as are needed for special printing and various other purposes, but which are not needed for simple blueprinting, will be noted in Chapter IV where these more advanced phases of printing are treated, or where a special reference is made to them for some other reason.

CHAPTER III

MAKING BLUEPRINTS

29. Essential Provisions. — The drawings from which blueprints are desired should first be reproduced on a translucent material, either tracing cloth or tracing paper. The tracing cloth is the best, and the white or bluish paper is better than the yellow. Tracing cloth is more transparent, prints better, is easier to work on and is more durable. The ink used on tracings should be black and opaque. The lines should be drawn a little heavier than those used on the drawings.

The makers of tracing cloth consider the smooth side as the right side. The dull side will take a pencil mark and is probably more used than the smooth side. It is a good plan to coat the cloth lightly with chalk dust, especially if the smooth side is used. The chalk dust can frequently be collected from a blackboard trough, and should be applied with an eraser. It should be dusted off lightly with a cloth before beginning the inking. This removes any grease which might prevent the ink from flowing properly.

Blue ink will not print at all. Red ink prints very lightly and should only be used where a light line is desired. A little Chinese white added to any colored ink will make a line opaque enough to print.

It is possible to make a blueprint from either a pencilled or inked drawing on bond or ledger paper. A pencilled drawing requires a short exposure because the pencil lines are not as opaque as ink lines, and if given a long exposure the lines on the blueprint will print a pale blue color. A pencilled line would naturally not give a clear cut line on the blueprint. Even an inked line will not reproduce with sharp edges when printed in this manner because the sun's rays have an opportunity to get underneath the line from the sides. However, when only a simple reproduction is desired, and when it will only be used for a short time, this method of making blueprints may prove satisfactory.

It is possible to make very good prints from an inked drawing on Reynold's two-ply bristol board. An exposure of five or six minutes in the summer sun is all that is required. An inked drawing on heavy paper may be reproduced as follows: Soak the face of the drawing with alcohol and clamp in the frame quickly. Alcohol does not evaporate readily in a printing frame. It will not spoil the sensitized surface if it soaks through the heavy paper or cardboard. Such printing requires long exposures, results in ragged lines due to the thickness of the paper, shows up the texture of the paper and is generally considered quite unsatisfactory.

30. Sunlight Printing.— All blueprints printed by sunlight exposure are printed, developed and dried in the same manner irrespective of the type of frame used. Remove the battens, the back-boards and the pad. The glass should be either wiped or cleaned if the frame has not been in use for several days. Dust and other particles are detrimental to the making of a clear print. Fig. 20 illustrates an extensively used type of commercial frame. In large sizes these frames have the back-boards in four and five sections. The tracing, A, Fig. 20, is placed on the glass, D, face down, and the printing paper, B, on top of it with its sensitized surface to the tracing. The pad, C, should then be placed over the paper. Care must be exercised to prevent the folding of either tracing or paper.

Both should lie smooth and in proper position. When desired, several narrow strips of the sensitized paper may be placed in the frame also. These are inserted in order that tests may be made to help determine the length of time of the exposure. To determine the exact amount of exposure at any time they should be placed under the edge of the tracing cloth so that the light must first go through the cloth.

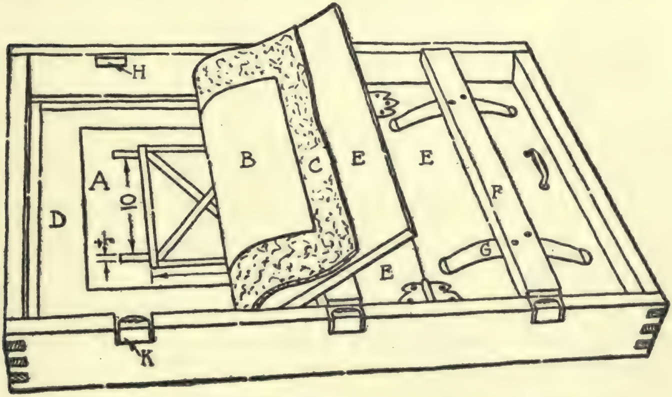

Fig. 20. Blueprinting Frame Showing Relative Positions of Tracing, Blueprint Paper and Pad

The back-boards, E, are hinged together in order that the operator may, from time to time examine the progress of the printing if he feels that is necessary; also, by being hinged, one section may be put in place at a time. This helps the operator to lay the tracing and paper flat if it has a tendency to curl.

After the pad and back-boards are in place the battens, F, are pressed into position. One end of a batten is slipped into the socket H. The piece of spring brass, K, is pulled outward;

the batten is pressed down, and the spring allowed to slip back over the end of the batten to keep it in place. Various devices are used on different frames to hold the battens in place. The springs, G, are made of spring brass. The pressure they exert against the back-boards keeps the tracing and sensitized paper in smooth contact with the glass, and in position. All of these operations should be done in subdued light.

Everything is now ready for the printing. To secure the best results the frame should be so placed as to receive the direct rays of the sun with equal intensity on all parts of the tracing. If no shadow is cast by the sides on the inside of the frame, the sun's rays are striking the frame directly. The printing should be done either out of doors, in an open window or through a large window which is not divided into small panes. Summer sunlight prints faster than winter sunlight.

The frame should be exposed for from four to eight minutes if the sunlight is bright and a Regular paper is used, and two minutes if Rapid paper. The transparency of the tracing is a factor entering into the time necessary for the exposure. When the paper protruding around the edges of the tracing has turned to a greenish-bronze color the print should be examined. If the lines of the print show out clearly on a grey background, the print has had sufficient exposure.

The print should then be placed in the bath. Place it face down or splash water over the face of it with the hand. Running water, especially a spray will wash the print most readily. When the lines show up white the print may be hung up to dry. The blue background will show up considerably darker after the paper is dry than it does while wet.

The following hints and suggestions for meeting special conditions, and other notes concerning blueprints and printing may be found helpful from time to time.

The longer the exposure the darker the blue background will become.

Prints should show perfectly white lines before being removed from the bath no matter what length of time is required.

When the water in the tray becomes discolored renew it. The chemicals dissolved in the water from the paper are harmful to the white lines.

Exposures made in the shade usually have a darker background than those exposed in direct sunlight.

An under-developed print has a tendency to wash out. Such a print may sometimes be saved by flowing a 1 to 25 hydrochloric acid solution over the wet face surface. A weak chlorine solution may also be used.

Changes may be made on a blueprint by bleaching out the blue, drying and making the necessary changes in ink. Any alkaline solution, such as made from washing soda or ammonia, will bleach the blue background. White ink or a Chinese white solution will sometimes prove satisfactory if the print is not to receive hard wear.

A strong alkaline rinsing water will frequently weaken prints unless it is neutralized. A little citric acid is good for this purpose.

Prints made on newly prepared paper wash out more readily than those printed on old paper, and prints made on new paper print slower than those on old paper.

Where a number of small tracings are to be printed they may be pasted together or attached to each other with stickers. They may then be handled more readily as one large sheet.

Sections in a drawing are sometimes indicated on the blueprint by tinting the section on the tracing. When printed, the section on the blueprint, which has been under the tinted area, will be a light blue, lighter than the background.

31. Printing with Electricity. — With the coming of the electric printing machine the problem of weather conditions was solved. Many concerns do not rely on sunlight printing at all. Some schools, too, have installed electric machines so that they are no longer dependent on the weather.

The principles involved in electric printing are identical to those of sunlight printing. The developing and drying may be done just as with sunlight printing also. Giving the print a bath in a bichromate of potash solution causes the contrast in colors to be more pronounced. Another bath in water is required if the print is washed in this solution.

32. Operation of Upright Electric Printing Machine.— An illustration of this type of machine is shown in Fig. 10. The tracings and paper are inserted between the glass and a curtain. The curtain pulls about the semi-cylindrical glass and holds the tracing and paper in position. An arc lamp with a vertical feed furnishes the printing light. The feed can be regulated. The lamp is slowly lowered on the axis of the cylinder, exposing with equal intensity all parts of the frame.

33. Operation of Continuous Electric Printing Machine.— The forward machine in Fig. 11 is typical of continuous electric machines. The tracings and paper are usually carried around on an endless canvas belt, and exposed either on a horizontal glass drum, or on a segment of such a drum. The light is furnished by a battery of arc lamps. The individual lamps may be shut off so that when a narrow tracing is being run only those lamps directly in front of the tracing need be lighted. The paper may be fed directly from a roll on this machine. Complete directions for operation should be secured of the firm from whom a machine is purchased.

The continuous electric printing, washing and drying machine, Fig. 11, does the work of the machine just described plus the washing and drying of the prints. Continuous prints of any length can be made on such a machine. The paper and tracings are fed in at the front and the finished prints come out at the rear. All operations are automatic after the paper has been fed into the machine. After the exposure the tracings drop off, and the paper by means of rolls is carried through a washing trough and spray. It continues on its way over the rollers and is smoothed and dried. Electricity or gas is used to furnish heat for drying the paper. Separate prints can be made in this machine just as easily as the continuous prints. A machine of this type has been known to print as much as 13,000 square feet of paper in a day. The washing and drying machine is attached to the printing machine and driven by the same motor. These large and very complete machines are only used where a large volume of work is required. Not only is electric printing wholly independent of existing weather conditions, but it is time and labor saving as compared with sunlight printing, and more uniform results are possible.

34. Makeshift Methods and Apparatus.— There are various ways of making blueprints other than by the use of specially constructed frames or machines. An electric printing device can be made with a large bottle and an electric bulb. Procure a large glass bottle with a mouth large enough to admit a 100-watt tungsten bulb. The glass should be as free from blemishes as possible. Wrap the tracing and paper around the bottle and place a cardboard or felt backing over them. The backing can be clamped securely with large rubber bands. Then the electric light should be suspended in the bottle. Tests will be necessary to determine the length of time required for the exposure. It is especially handy for a person who wishes only a few small prints, and whose only opportunity for printing is at night.

It is possible to make a small blueprint directly on a window pane. Place the tracing and paper against the glass just as you would in a printing frame. It is a good plan to attach the tracing and paper together with narrow gummed stickers to keep them in their proper relation and to prevent slipping. This allows for frequent inspection of the print, which is quite necessary. Back the tracing and paper with a towel folded to two or three thicknesses. The towel in turn should be backed with a board. A small drawing board is good for this purpose. Some suitable device may be erected to hold the board in position, or it may be held with the hands.

Another method that has been employed in the making of small prints is as follows: Spread one, or better, two or three towels on the floor where the sun can strike directly. Put the blueprint paper and tracing on the towel and cover with a piece of thick plate glass. Pressure should be applied at first to keep the paper smooth. After a short time the weight of the glass should prove sufficient.

A still simpler but not quite as satisfactory procedure is to plane off a board with a slightly curved surface. The tracing and paper are stretched and tacked over the board, the curvature holding them snugly to the board. Exposure is then made just as with a printing frame. No glass is needed.

A blueprint may be dried rapidly by ironing it with an electric iron. An ironing pad can be made of cotton batting covered with cheese-cloth. Care must be exercised not to get the iron too hot or the print will be ruined. Iron on the back side of the print.

CHAPTER IV

SPECIAL PRINTING

35. Vandyke Paper. — "Vandyke" is the term quite generally applied to all prints of sepia and black-brown color. The Eugene Dietzgen Company manufacture this paper under the trade name of "Vandyke Solar Paper." Likewise the Keuffel and Esser Company manufacture a similar paper under the trade name of "Maduro." These papers can be purchased in three weights, thin, medium and heavy. A Vandyke cloth is also manufactured in two weights, thin and medium.

Vandyke papers are made for two purposes, the most important of which is for the making of negatives from tracings. From these negatives blue-line or black-line prints can be made. The blue-line print is made on ordinary blueprint paper from the Vandyke negative. The so-called black-line print is made on Vandyke paper from the Vandyke negative. The thin paper is used almost exclusively for negatives, and the heavier weights and the cloth for black-line prints.

The term "black-line print" is a trifle misleading and not technically correct, as the print is a black-brown color. It is a trade term which has come into common usage. There is a paper made for a real black black-line print which will be taken up later. It is not used extensively, principally because of the high price.

Quoted prices on Vandyke papers and cloths are not as valuable for comparison as those on apparatus and blueprint papers. Prices on these papers and the other special papers mentioned in this chapter fluctuate with market conditions. For current prices inquire of dealers or write to the firms manufacturing the papers.

36. How to Make a Vandyke Negative.—To make a print which is to be used as a negative the inked side of the tracing is turned toward the *paper* instead of toward the glass. The resulting print is, therefore, reversed. See Fig. 22. The print shows up with white lines on a dark brown background. The dark background being impervious to light makes it valuable as a negative from which blue-line or Vandyke black-line prints can be made.

The exposure of a Vandyke print has been sufficient when the background of the print, not covered by the lines of the tracing, has turned to a light bronze color. The print should be washed and thoroughly rinsed on both sides with a spray. Or it may be left in running water for 15 or 20 minutes. The background will change to a sepia brown color and the lines will turn white. The print is "fixed" by either floating it in a solution of hyposulphite of soda, or laying it on a board or table and floating or brushing on the solution. The solution should be in the proportion of 1 oz. of hyposulphite of soda to a quart of water. Fixing salts for the various brands of paper are usually furnished with the paper. Complete directions for the use of the fixing salt accompany it. The fixing solution darkens the sepia brown to a black-brown color. The white lines remain white. After the fixing the print should be washed again for 20 to 30 minutes and hung up to dry.

It is possible to use the negative as it is now, but much quicker and better results are obtained if the negative is transparentized. This is done by oiling the paper. A clear oil or white grease should be used. White tube vaseline is satisfactory. Transparentizing solutions are also sold by dealers and manufacturers of blueprint supplies. A mixture of banana oil and white vaseline makes a good transparentizer. Mix by heating in a covered utensil. The banana oil causes a quick drying of the surface. Too much oil should not be applied. The oil should be put on the surface of the negative which is toward the glass, that is, the back side. Cotton waste or a soft cloth should be used for applying the transparentizer.

37. How To Make Black-line Prints (dark brown color).— Black-line prints are made from a Vandyke negative on Vandyke paper. The latter is usually of medium heavy weight and not freshly prepared. The reversed print or negative is placed in the frame with its back to the glass. The lines on the black-line print will show up dark brown on a white background. This process makes the shading in dark lines also, which is much to be desired, and which is one of the great advantages of this kind of a print over a blueprint.

The printing and developing is done much the same as for the Vandyke negatives. More care must be exercised, however. The print is not floated in the water, but merely dipped to wet the exposed surface and start the printing. It is then floated in or treated with the fixer immediately. If these directions are not followed the unexposed parts, the background, will turn yellow, and the print will have lost one of its distinguishing qualities. See Fig. 21.

One can also make what might be termed "brown prints" on Vandyke paper, a reproduction of the tracing in white lines on a black-brown background. Such a print has no qualities that the blueprint does not possess, and the paper is more expensive. See Fig. 23.

38. How To Make Blue-line Prints. — A blue-line print is made on ordinary blueprint paper from a Vandyke negative. The lines, including shading, are dark blue on a white background. See Fig. 21. This print is becoming popular and is being used for architectural and topographical work more and more. Blue-line printing is simpler than black-line printing, being the same as for ordinary blueprinting. When ordering blueprint paper for blue-line prints it is well to state in the order that the paper is to be used for that purpose.

It is possible to secure direct blue-line paper which prints a blue line on a white background direct from the tracings. Such papers cost more than blueprint papers and require special developing and fixing. Detailed directions and the developer and fixer usually accompany each roll. The Eugene Dietzgen Company makes a direct blue-line paper known as "Lumine."

39. How To Make *Black* Black-line Prints.—Manufacturers of blueprint papers make direct black-line papers known under various trade names, which when exposed, developed and fixed actually produce a black line on a white background. These are positive papers, the printing is done direct, and the result is a fac-simile of the tracing in black lines. These prints can be altered, shaded, added to and colored. They require a water bath only, but the method of printing is not as simple as blueprinting. These direct black-line papers cost much more than ordinary good blueprint papers, and the prints deteriorate more rapidly.

40. Blueprints From Typewritten Sheets.— A moderately thin, hard surfaced paper and new black typewriter ribbon should be used. Place the black carbon paper in the typewriter *under* the paper with the carbon side toward the paper. When a key is struck an impression will be made on *both* sides of the paper. Handle the typewritten sheets carefully so they will not be smudged.

These sheets cannot be transparentized in the usual way. To rub oil on the paper would smear it. Lay the typewritten sheets between pieces of oiled flannel cloth. Place several thicknesses of paper or some cardboard over them and put in a press or place a weight upon them. They should remain thus for several hours.

A dull surfaced white tracing paper can now be secured, which when typewritten on as described in the first paragraph of this section, will be found fairly satisfactory for immediate printing without first transparentizing.

When printing from typewritten sheets which have had to be transparentized allow an over-exposure, and wash in a hydrogen peroxide solution. Mix the latter in the proportion of 1 teaspoonful to 4 gallons of water. The peroxide will deepen the blue background. Peroxide may be placed in any blueprint bath and a greater contrast between the white lines and blue background will result.

Another method of making typewritten blueprints is to make a negative on a piece of new black carbon paper. This negative makes a print with blue lines on a white background. The carbon paper is placed with the carbon side out in the typewriter, and a thin sheet of hard surfaced paper is placed over it. The ribbon is removed. The better the quality of the paper the better will be the impressions of the letters on the carbon paper. The carbon adheres to the white paper where the key strikes, and an impression of the letter is made on the carbon sheet. The carbon surface must be placed toward the glass when printing. Great care must be exercised in handling the carbon negative, as a finger mark will ruin it.

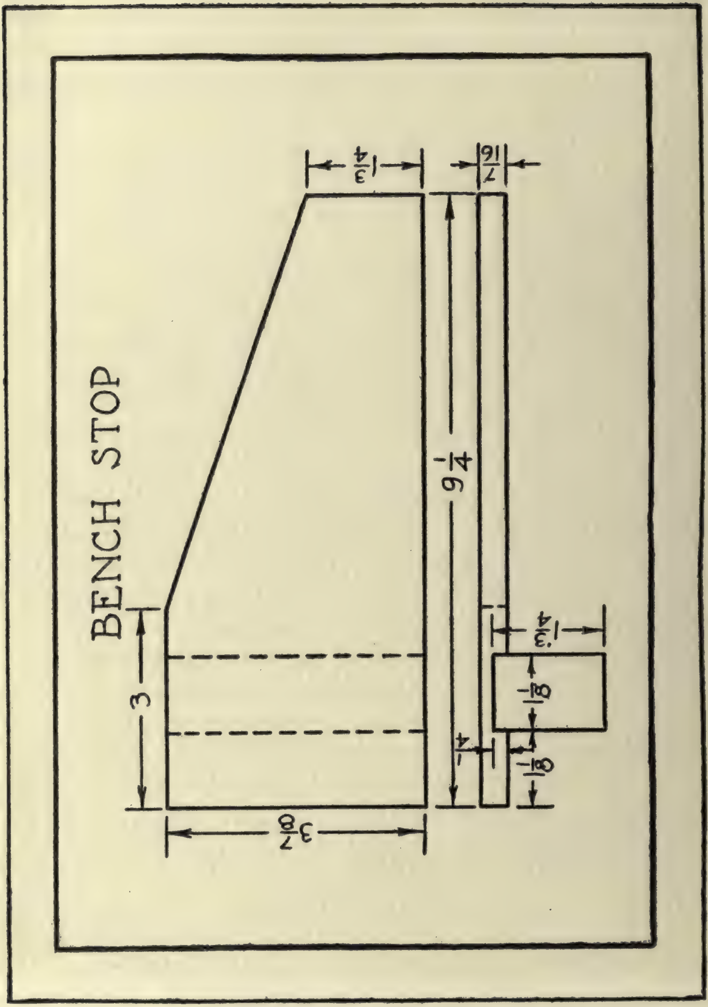

Fig. 21. Tracing, Blue-line or Black-line Print

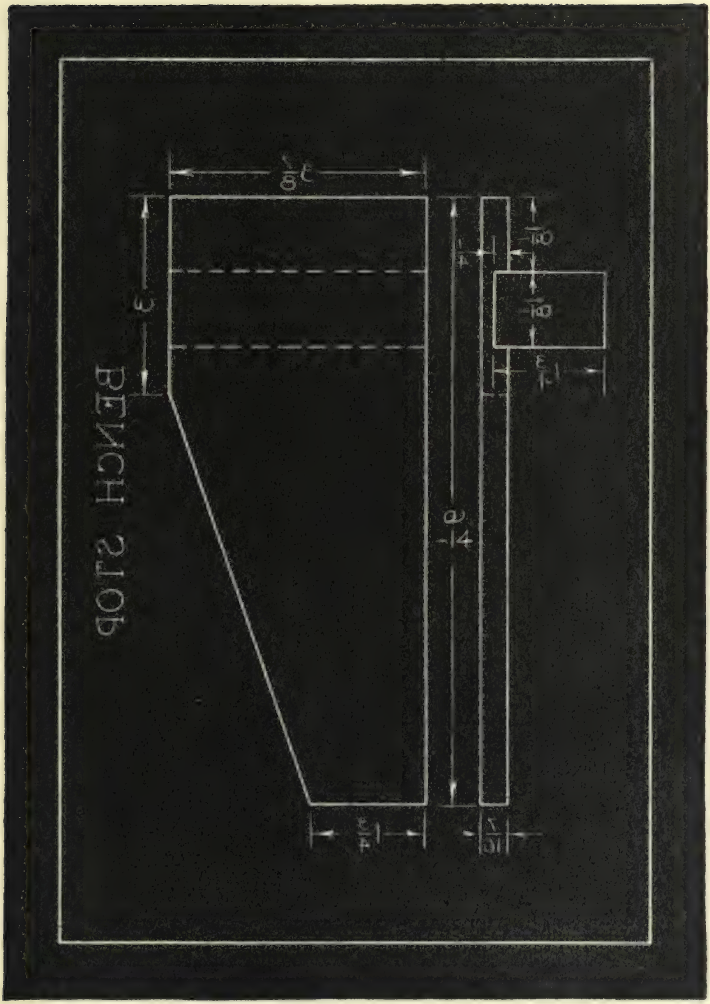

Fig. 22. Vandyke Negative

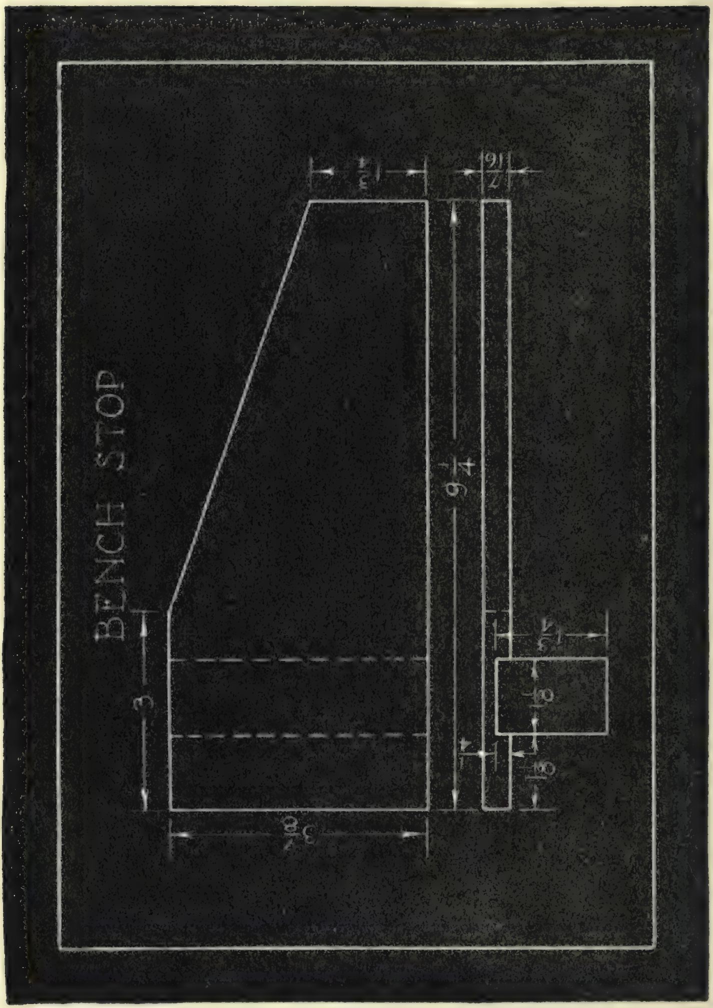

Fig. 23. Blueprint or "brown" print

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